

# **Structural materials for fusion reactors**

## **Scientific Achievement**

In recent experiments on ferritic alloys we have recently found a significant difference with alloy composition in the microstructural response to irradiation, which corresponds to a bulk mechanical property change at a similar composition. In a collaboration between the Department of Materials at the University of Oxford and the Materials Science Division at Argonne National Laboratory, experiments which employ the unique transmission electron microscope and in situ ion irradiation user facility at ANL were performed on a series of Fe-Cr alloys. Enhanced nanometer-sized defect formation with Cr concentrations up to 11 % have been found and correlated with a decrease in mechanical hardening and embrittlement in similar alloys.

## **Significance**

A long term solution to problems of energy production, green house gas generation, and pollution control may rest with controlled nuclear fusion reactors. Candidate structural materials for such reactors include low activation ferritic steels. Understanding and eliminating deleterious irradiation effects in these materials is the goal of continuing experiments of this collaboration using the ANL facility.

## **Performers**

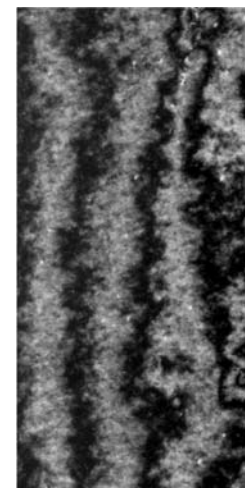
M. A. Kirk (ANL-MSD)

Z. Yao and M. L. Jenkins (University of Oxford)

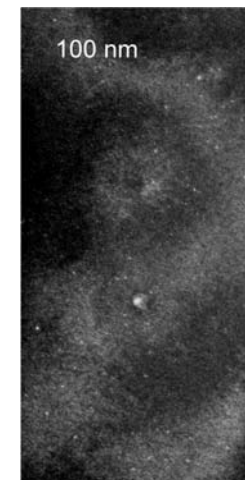
# Structural materials for fusion reactors

**Transmission electron microscopy images of irradiation damage microstructure (nanometer-sized white dots) in Fe and Fe-11%Cr.**

**This data, from the TEM-Accelerator user facility in the EMC at ANL, illustrates a greater rate of formation of dislocation loops in the 11%Cr alloy.**



$2 \times 10^{14} \text{ ions cm}^{-2}$   
**Fe**



$3 \times 10^{13} \text{ ions cm}^{-2}$   
**Fe-11%Cr**

Full data sets of defect density vs ion dose ( $\text{cm}^{-2}$ ) display profound sensitivity to all Cr additions investigated. The mechanism to produce dislocation loops at a rate more than an order of magnitude greater in the Cr alloys than in pure Fe is unknown, but is under study. Sensitivity in this range of Cr concentration of mechanical property changes with irradiation is also found. Understanding this correlation will lead to an improved structural alloy for use in construction of future nuclear fusion reactors for unlimited clean energy production.

